

OBSERVATIONS ON THE BIOLOGY OF *SEXTIUS VIRESCENS* (FAIRMAIRE) (HOMOPTERA, MEMBRACIDAE) ON *ACACIA* IN VICTORIA

By L. Cookson and T. R. New

Department of Zoology, La Trobe University, Bundoora, Victoria 3083.

Abstract

Sextius virescens is univoltine near Melbourne, Victoria, with eggs being the major overwintering stage. Adults may live for more than 30 weeks. Host range, reproductive and defensive behaviour are briefly described, and notes given on insect predators and parasites. Records of Mymaridae, Trichogrammatidae and Pipunculidae are the first from an Australian membracid.

Introduction

The green membracid *Sextius virescens* (Fairmaire) is one of the more common insects on acacias in south-eastern Australia (Froggatt, 1902), but little information has been published on its biology and life history. Kitching (1974) described and differentiated the early stages of *S. virescens*, and Kitching and Filshie (1974) used *S. virescens* for their study of the anal apparatus of membracid nymphs. Virtually no biological information is available for other Australian Membracidae, although a number of host records were summarised by Evans (1966).

A one year study of *S. virescens* near Melbourne, Victoria, augmented by observations over several years, has enabled some clarification of its life history to be made, and has yielded preliminary data on its insect parasites and predators in this area.

Methods

Direct total counts of adults and nymphs were made, and the incidence of eggs noted at weekly or fortnightly intervals from February 1978 to February 1979 on 93 *Acacia* trees (all < 3 years old and mostly ca. 1 m in height) representing 18 species (Appendix 1) on the La Trobe University campus. Additional larger trees in the same area were used as the source of laboratory material and membracids were maintained in the laboratory on potted seedlings, mainly of *A. decurrens*. Terminal branch lengths were cut and brought to the laboratory for examination for eggs, and possible predators were collected by direct searching (small trees) or beating (larger trees).

Life History

The months in which eggs, nymphs and adults were found are shown in Fig. 1, which clearly shows that *S. virescens* is univoltine. Adults first appeared in December, and were abundant from January until March. Thereafter, there was a progressive decline in adult numbers, although a few persisted through the winter until late September and early October. Oviposition commenced about one month after appearance of the first adults, and healthy unhatched eggs were present until the following November, although many hatched in October. During most of November and December only nymphs were present, and a few late instar nymphs occurred until April (on three of 93 trees). Most became adult within about two months of eclosion.

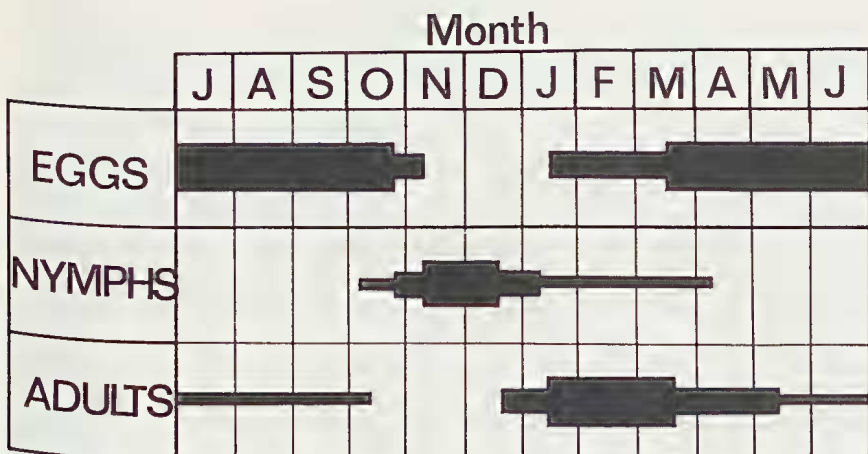


Fig. 1. Summary of periods of occurrence of eggs, nymphs and adults of *S. virescens* on *Acacia* near Melbourne, 1977-78 (width of bar proportional to abundance, months denoted by initial letter from July to June).

The egg is thus the major overwintering stage, and eggs remain unhatched for eight to nine months. In 1978 most hatched during the latter half of October. In a sample taken on October 19 most eggs were unhatched but showed the eyespots characteristic of advanced embryos and on October 31 large numbers of first and second instar nymphs and few unhatched eggs were found. This relatively short hatching period is suggestive of an egg diapause. Early instar nymphs were scarce after late November.

Marking, using coloured nail polish, and subsequent release of field-collected adults showed that longevity could be as long as 33 weeks or more. Monitoring of marked adults also showed that an individual may occur on more than one host species, and that adults from the same original host may disperse to several different hosts.

Many adults undergo a progressive colour change with age, changing from bright green to dull yellow. Yellowing starts in the region of the suprahumeral horns, and progresses posteriorly. It does not occur in all individuals, however, and thus differs from the more general colour change associated with maturity in some other membracids (Wood, 1975).

Mating

S. virescens does not show any elaborate female display such as, for example, that recorded in *Umbonia crassicornis* Anyot and Serville by Wood (1974). Before mating, *S. virescens* males initially either stopped beside, or walked behind, a female. The male then sits on the female, usually directly above her, with his head at or behind the level of her suprahumeral horns for one or two days. Up to three males were seen sitting on one female, even if unattended females were near. Copulation occurs with the partners facing in opposite directions which is the usual membracid position.

Oviposition

Eggs are laid in a single row in slits cut through the bark of young *Acacia* branches (Froggatt, 1902). The eggs are deposited between the bark and underlying cortex.

Initially the ovipositor is lowered at right angles to the branch and the substrate palpated repeatedly until a site for commencement of cutting has been selected. The tip of the ovipositor is then forced into the bark, and the female moves progressively backwards, opening a narrow vertical slit. After a short period of rest, during which the ovipositor is sheathed, the abdomen is arched forwards and the ovipositor used to cut deeper and push laterally into part of the slit, broadening the cut from about 0.1 mm to about 0.3 mm wide. After cutting in this manner for a single arching of the abdomen, an egg is inserted into the slit. The ovipositor is withdrawn, sheathed, and the process repeated after several minutes until a row of eggs has been laid. One female observed took an hour to lay eight eggs.

Slit lengths and numbers of eggs per slit found in field-collected samples from three *Acacia* species are shown in Table 1. Slits in *A. decurrens* were usually slightly longer than on the other two tree species, and the differences may reflect structural features of the different hosts. In particular, *A. verticillata* has whorls of phyllodes separated by only short lengths of stem.

TABLE 1
Oviposition slit lengths of *Sextius virescens*, and numbers of eggs contained in slits, on three *Acacia* species (bulked samples, 1978)

Host	No. of slits examined	Slit length (mm, mean \pm s.d., range)	Egg number (mean \pm s.d., range)
<i>A. decurrens</i>	75	9.21 \pm 2.0 (2.5-16.5)	13.9 \pm 4.3 (0-25)
<i>A. verticillata</i>	25	7.18 \pm 1.5 (4.5-10.0)	12.2 \pm 3.5 (6-19)
<i>A. acinacea</i>	25	7.40 \pm 1.6 (3.0-11.0)	12.0 \pm 3.2 (5-16)

In some instances, slits were not completely filled with eggs, and several empty slits were found. These may reflect females being distracted during oviposition. More rarely the females make individual slits for each of several eggs.

Dissection of females throughout their period of occurrence gave an overall average ($n = 160$) of 16.2 ± 6.3 fully developed (chorionated) eggs, a figure slightly higher than the average number contained in a single slit. The greatest number of developed ovarian eggs was 35, strongly suggesting that a single female may sometimes make more than one slit at oviposition. Close synchronisation of eclosion of nymphs from adjacent slits may also suggest this. Newly adult females had a mean ovarian count of only 0.4 eggs, and females taken from precopulatory pairs contained a mean of 5.1 eggs ($N = 10$ in each case).

Females appear to be considerably more abundant than males. Overall sex ratio for samples examined was 21% males ($N = 978$), with several small populations containing only females. No samples from any individual tree were

found with more males than females (maximum 46.4% males, $N = 181$). In general, the proportion of males was higher in close aggregations than in more dispersed 'groups', possibly reflecting a greater tendency for males to disperse.

Natural enemies

There appear to be no records of natural enemies of Australian Membracidae and, in general, the family has few parasites and predators recorded from elsewhere in the world (Funkhouser, 1950). Wood (1975) discussed predation by lizards on several new world Membracidae, and Hinton (1976) noted the possible defensive function of aggregation. Hinton commented that 'the mere presence of the adult above a batch of eggs may ensure their greater survival simply by blocking the approach of casual predators and parasites'.

All stages of *S. virescens* were examined for the incidence of insect parasites and several possible arthropod predators were tested against them under artificial conditions to determine whether they could utilise them as prey. No vertebrate predators of *Sextius* were observed.

Parasites

One (possibly two) species of Mymaridae and one of Trichogrammatidae were reared from *S. virescens* eggs, and four adult *Sextius* were found parasitised by a pipunculid fly. No parasites were found in *Sextius* nymphs.

The Mymaridae are two of three known species (all undescribed) which are apparently referable to a new genus of Anagrini, near *Stethynium* Enoch, (New, unpublished). The trichogrammatid is represented only by four somewhat damaged specimens. The pipunculid was determined as *Pipunculus* sp. by Dr D.H. Colless (CSIRO). Specimens of all will ultimately be deposited in the Australian National Insect Collection, Canberra. Comments on the individual species follow.

One species of mymarid was common. Fifty egg slits (total 677 eggs) gave an overall level of parasitism of 39.4%. Thirty eight of these slits contained some parasitised eggs, but only in seven were all eggs parasitised. The wasp probably oviposits in *S. virescens* eggs before winter, and its pupae were found in membracid eggs in late winter. Parasites emerged mainly during September and were found walking on infested branches in the field at that time. They appeared to attack mainly eggs that were at least partially exposed. Eggs enclosed completely by the slit, or by encrusted dried sap or debris were only rarely parasitised.

A single specimen of a second mymarid species was found in a box containing *S. virescens* eggs in the laboratory in August 1978. The association has not been confirmed, but there did not appear to be any other possible host in the container.

The trichogrammatid is known from one clear incidence. An egg slit on *A. decurrens* examined on October 19 contained an adult wasp in the act of oviposition. Wasps subsequently emerged from several other eggs in the same slit. In contrast to many other egg parasites, which normally attack before

appreciable development of the host embryo has occurred, this species can successfully attack well-developed eggs.

The fully developed pipunculid larva broke out of the adult *Sextius* at the junction of the thorax and abdomen. The larvae pupated on the cage floor about a day later, and the two adults reared emerged after about three weeks. The parasitised adults were field-collected, but it is likely that the fly attacked later nymphs, a habit common in Pipunculidae reared from other hosts.

It thus appears that the greatest parasite mortality is inflicted during the egg stage, predominantly by one species of mymarid.

Predators

Adults and nymphs of the mantis *Orthodera ministralis* (F) were observed feeding on adult *Sextius* in the field. In the laboratory, adult *O. ministralis* could eat up to seven adults a day. First instar *Orthodera* were unable to handle *S. virescens* larger than third instar, but readily fed on young nymphs. Adult earwigs (*Forficula auricularia* L), and last instar larvae of *Chrysopa edwardsi* Banks also fed readily on nymphs of *S. virescens* under confined conditions, but could not capture adults. Several spiders were seen feeding on adult membracids on *Acacia* trees, and a species of Thomisidae ate up to two adults a day in the laboratory.

Discussion

S. virescens was by far the most abundant membracid found in *Acacia* during this study. It is univoltine, with eggs comprising the major overwintering stage, and the level of egg parasitism is high. Balduf (1928) showed (for parasitism of *Ceresa bubalus* eggs by *Polynema striaticorne* Girault) that avoidance of synchronous parasitism of all eggs could be important in ensuring the continuity of the parasite, as growth or shifting of bark could influence egg availability. This may possibly occur in *S. virescens*, as the long period of egg incubation and rapid growth of young *Acacia* branches could combine to affect egg position. Maternal brooding and such devices as a 'froth cover' (Wood and Patton, 1971: *Enchenopa binotata* Say) are not available for protection of *S. virescens* eggs, and egg insertion into plant tissue is thus the major 'protective mechanism' available. It is not known whether the level of parasitism found reflects only one generation or several compounded generations of the parasite over the period: laboratory emergences strongly suggest only a single parasite generation, as most parasites emerged over a very short period.

In contrast to eggs, the nymphs and adults have only low levels of parasitism. The incidence of *Pipunculus* (although low) is of considerable interest in documenting an unusual host record, as these flies are more usually associated with other groups of Homoptera. Most of the few host records of Australian Pipunculidae are of species from leaf hoppers (Hardy, 1964), and Co (1966) indicated that each pipunculid genus is usually limited to one host family, e.g. *Pipunculus* to Cicadellidae.

No evidence was found of egg predation, but several predators of later stages are recorded. Both mantids and spiders were listed amongst predators

of membracids by Funkhouser (1917), and these were the only field records of predators during our work. *Chrysopa edwardsi* is the most abundant chrysopid on *Acacia* in southern Victoria and, as larvae readily ate membracids when confined, this may reflect a regular feeding association.

Kitching and Filshie (1974) suggested that the anal whip of *S. virescens* nymphs might act as a defense against natural enemies, believing that the whip (which is extruded and 'whipped' when nymphs are physically disturbed) might make it difficult for predators to manouvre to grasp the prey. Against the above-mentioned predators, however, the whip was used only after the nymph had already been gripped or picked up, and its action did not then cause the predators to release their prey. We suggest that the anal whip could also be a useful adaptation to a sedentary existence. Nymphs of both *S. virescens* and *Cebes transiens* (Walker) were seen on many occasions with small drops of honeydew dispersed on the substrate in a semicircle around the abdomen at a distance approximating the length of the extended anal whip. It is well known that body contamination with honeydew is deleterious to some Homoptera (Way, 1963), and *S. virescens* nymphs with honeydew on their bodies appeared to be agitated and often to have their movement substantially impaired. Hinton (1976) showed that gregarious Membracidae (which are usually ant-attended) often have shorter anal tubes than solitary species. However, some more solitary species (such as *C. transiens*) and individuals (many *Sextius*) are often only irregularly ant-attended, and removal of honeydew may become relatively important.

Other membracids found on *Acacia* during this work were *Ceraon vitta* (Walker) (on *A. decurrens*, *A. pycnantha*, *A. retinodes*), *Cebes transiens* (Walker) (*A. decurrens*) and *Acanthucus trispinifer* (Fairmaire) (*A. decurrens*). Host records for the latter two species have apparently not been previously published, but *C. vitta* was recorded from *A. decurrens* by Goding (1903), who also recorded *Pogonella bispinus* (Stal) from this host. Evans (1966) commented that several species are known to live on acacias, which he noted as being hosts of very few Australian cicadellids. However, little is known of the hostplant relations of most Australian Membracidae and speculation that they may 'specialise' on acacias is premature. Clearly *S. virescens* utilises host species from several sections of the genus *Acacia*, but is known only from *Acacia*, and there is no evidence of transfer between *Acacia* and herbaceous plants as Balduf (1928) found for *Ceresa bubalus* (F). Although there were marked differences in numbers of individuals on different *Acacia* species, there was also considerable variation in numbers between plants of the same species. It is, therefore, difficult to suggest whether particular host species are 'preferred' by *S. virescens* as differences in numbers may merely reflect differences in individual tree condition. Tendency to form aggregations introduces a further bias into such estimations based on numbers alone. Although *S. virescens* is noted as being 'subsocial' by Hinton (1976) [apparently extrapolating from a comment by Kitching (1974) that 'all stages may be found together on the same plant'], this behaviour is much less pronounced than in some other membracids (Hinton, 1976), and 'secondary' aggregations are formed by adults becoming grouped.

Acknowledgements

This paper includes data from a thesis submitted for the B.Sc. Honours degree at La Trobe University by L.C. Additional data were obtained with the technical assistance of Mrs J. TenBerge and Miss P. Fischer. We also thank Dr D. H. Colless for his identification of the pipunculid parasite.

Appendix 1

List of *Acacia* species on which *S. virescens* were found, 1978.

<i>A. acinacea</i> Lindl.	<i>A. mucronata</i> Willd.
<i>A. armata</i> R.Br.,	<i>A. obliquinervia</i> M. Tindale.
<i>A. botrycephala</i> (Vent.) Desf.	<i>A. podalyriifolia</i> A. Cunn.
<i>A. buxifolia</i> A. Cunn.	<i>A. pravissima</i> F. Muell.
<i>A. decurrens</i> (J. Wendl.) Willd.	<i>A. pycnantha</i> Benth.
<i>A. floribunda</i> (Vent.) Willd.	<i>A. retinodes</i> Schlecht.
<i>A. hakeoides</i> A. Cunn.	<i>A. stricta</i> (Andr.) Willd.
<i>A. mearnsii</i> Willd.	<i>A. suaveolens</i> (Sm.) Willd.
<i>A. melanoxylon</i> R.Br.	<i>A. verticillata</i> (L'Herit.) Willd.

References

- Balduf, W. V., 1928. Observations on the buffalo tree hopper, *Ceresa bubalus* Fabr. (Membracidae, Homoptera) and the bionomics of an egg parasite, *Polynema striaticorne* Girault (Mymaridae, Hymenoptera). *Ann. ent. Soc. Amer.* 21: 419-435.
- Coe, R. L., 1966. Diptera: Pipunculidae. *Handbk. Ident. Br. Insects* 10(2c): 1-83.
- Evans, J. W., 1966. The leafhoppers and froghoppers of Australia and New Zealand (Homoptera: Cicadelloidea and Cercopoidea). *Mem. Aust. Mus.* 12: 1-347.
- Froggatt, W. W., 1902. Insects of the wattle trees. *Agric. Gaz. N.S.W.* 13: 701-720.
- Funkhouser, W. D., 1917. Biology of the Membracidae of the Cayuga Lake Basin. *Mem. Cornell Univ. agric. Exp. Stn.* 11: 177-445.
- Funkhouser, W. D., 1950. Homoptera, fam. Membracidae. *Genera Insectorum* 208: 1-383.
- Goding, F. W., 1903. A monograph of the Australian Membracidae. *Proc. Linn. Soc. N.S.W.* 28: 2-41.
- Hardy, D. E., 1964. A re-study of the Perkins types of Australian Pipunculidae (Diptera) and the type of *Pipunculus vitiensis* Muir from Fiji. *Aust. J. Zool.* 12: 84-125.
- Hinton, H. E., 1976. Subsocial behaviour and biology of some Mexican membracid bugs. *Ecol. Entomol.* 2: 61-79.
- Kitching, R. L., 1974. The immature stages of *Sextius virescens* (Fairmaire) (Homoptera: Membracidae). *J. Aust. ent. Soc.* 13: 55-60.
- Kitching, R. L. and Filshie, B. K., 1974. The morphology and mode of action of the anal apparatus of membracid nymphs with special reference to *Sextius virescens* (Fairmaire) (Homoptera). *J. Entomol. (A)* 49: 81-88.
- Way, M. J., 1963. Mutualism between ants and honeydew-producing Homoptera. *Ann. Rev. Entomol.* 8: 307-344.
- Wood, T. K., 1974. Aggregating behaviour of *Umbonia crassicornis* (Homoptera: Membracidae). *Can. Ent.* 106: 169-173.
- Wood, T. K., 1975. Defense in two pre-social membracids (Homoptera: Membracidae). *Can. Ent.* 107: 1227-1231.
- Wood, T. K. and Patton, R. L., 1971. Egg froth distribution and deposition by *Enchenopa binotata* (Homoptera: Membracidae). *Ann. ent. Soc. Amer.* 64: 1190-1191.